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Computer Systems Planning Report

March 1974

Office of Joint Computer Support

Directorate of Management & Services

Central Intelligence Agency

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I. Introduction

A five year plan designed to provide the computer systems required to support the projected work load of the OJCS customers and the SAFE system is presented in this paper. The current work load of the computer center was analyzed and a projection made based on the best available information. Changes to the current configuration were planned to provide the required capacity to support the projected increased work loads. In order to maintain stable systems, hardware changes were generally planned well before (six months or longer) the increased requirements dictated.

When planning for computer systems it is necessary to order new systems a year before they are installed. An additional six months may be added to allow the systems to settle down so that hardware is ordered 18 months before an increased work load is expected. Given this type of lead time, for this plan to be effective, it must be revised yearly as better information on real work load requirements become available.

Section II of the plan describes the projected work load that was used to derive the planned changes. Performance objectives of the plan are described in section III and a description of the current system is given in section IV. The planned changes are given in section V, the budget implications are in section VI, Section VII discusses the major alternatives considered,and outstanding issues are discussed in section VIII.

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II. Work Load Projection

The following load projections were the basis of the configuration changes proposed in the plan. The batch work load is a 22 percent growth rate per year projection, which should be the upper bound for the batch work load during the planning period. The terminal workload projections are "best-guess" estimates which were compiled from projections made by the Ad Hoc Planning Group and customers. Projections of historical data were not used to predict terminal work load since new functions are being planned for which there is no historical data available.

A. Batch Work Load Projection

Table 1 shows the average daily batch work load projected for the planning period. The CPU hours are shown in 370/168 CPU hours since 168's are being proposed. The projections were done in 360/65 CPU hours using a factor of 1:7 to convert 195 CPU hours to 65 CPU hours, and then a factor of 4:1 to convert 65 CPU hours to 168 CPU hours.

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		Average Daily Load as of July 1				
		1974	1975	1976	1977	1978
Normal Jobs (CPU < 4 Min.)	Jobs	2000	2300	2600	2900	3200
	CPU HR.	9.	11.	13.	15.	17.
Long Jobs (CPU > 4 Min.)	Jobs	90	110	130	150	170
	CPU HR.	19.	22.	25.	28.	31.
Total Jobs	Jobs	2090	2410	2730	3050	3370
	CPU HR.	28.	33.	38.	43.	48.

Table 1. Projected average daily batch work load with CPU load expressed in 370/168 CPU Hours.

B. Terminal Work Load Projection

The OJCS center supports numerous dedicated user terminal systems that perform a single function and support a few terminals, and two general purpose terminal systems CP/CMS and GIM-II, that support many users and do a variety of functions according to commands entered by the terminal user. A third general use system, SAFE, is being planned to specifically support the intelligence analyst. The projections assume that no additional dedicated terminal systems other than graphic applications, are added and that the current dedicated user systems continue through the planning period.

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The projection of terminal load is the expected number of active terminals during the peak hour. The number of physical terminals assumes that customers using more than one system will be able to access both systems from a single terminal as is presently done by SAFE and GIM-II users. Since SAFE is a developmental project, the physical terminals projected for SAFE are shown separately.

Table 2 show the projected number of physical terminals that will use OJCS terminal system, Table 3 shows the projected activity of the general use systems, and Table 4 shows the projected load of the dedicated user systems.

Projected Physical Terminals
As of July 1

	1974	1975	1976	1977	1978
OJCS	230	350	450	550	650
SAFE	6	18	50	150	300
Total	236	368	500	700	950

Table 2. Projected physical terminals connected to OJCS systems.

General User Systems
Projected Load
As of July 1

	1974	1975	1976	1977	1978
CP/CMS	108	150	200	250	300
GIM-II	16	32	45	55	65
SAFE	3	9	25	50	100
Total	127	191	270	355	465

Table 3. Projected number of active terminals for General Use Systems during peak hours

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Application	Region	Projection of Dedicated User Systems As of 1 July 1974	1975	1976	1977	1978
SANCA	110K	2	2	2	2	2
BR90	230K	1	1	1	1	1
QT2260	140K	2	2	2	2	2
AEGIS	490K	12	12	12	12	SAFE
MAD-TP	110K	2	2	2	CDS	
ISG-OLDE	115K	2	CP/CMS			
2250-Graphics	250K	1	2	2	2	2
SHOEBOX	250K	1	1	1	1	1
Safe Development						
COLTS	200K	4	4	SAFE		
OLTA	150K	6	4	SAFE		
RECON	200K	4	-			
DODIR	180K	2	2	SAFE		
SQUIRL	56K	2	-			
SAFE-OLDE	130K	3	CP/CMS			
Total	2611K					

Table 4. Projection of dedicated user terminal systems.

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III. Performance Objectives

The performance objectives included in the plan are an initial effort to explicitly state the minimum level of service the center is to provide. Often times there is considerable disagreement between concerned parties as to the "level of service" provided by the OJCS computer center. Some of the statistics chosen are not yet calculated on a regular basis, while others chosen may not accurately reflect the service as received by the customer. However the objectives stated in the plan should be a starting point for trying to relate center performance to measurable statistics. Much additional work will have to be done in defining the proper measures of performance. Even given good measures of performance, it is difficult to state the "required" level of service when talking about spending additional money to raise the level of service (i.e. MTBF) of a system from its current level to a higher level. As experience is gained measuring the performance of the services provided, it is expected that some of the objectives, and some of the measures chosen, will be revised.

A. Batch System Performance Objectives

The statistics selected to measure the quality of the batch service are average job turnaround, system availability, and system stability. Job turnaround is defined as the elapsed time from the time the job was read, to the time the job finished printing. To calculate turnaround time for a given time period, the turnaround time of C jobs submitted between 0800 and 1630 is averaged. System

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availability is defined as scheduled uptime divided by system uptime. System stability is measured by calculating the Mean Time Between Failures, (MTBF) which is a measure of the frequency of system outages.

The MTBF and availability objective for the ASP system, which is defined as the ASP support and at least one local or remote main is:

MTBF = 24 Hours

Availability = 95%

The job turnaround objective for jobs is as follows:

Class of Jobs	Average Job Turnaround
A	30 min. + elapsed time on main and printer.
C - Nosetup	1 hour
C - Setup	2 hours
D & E	By 08:00 the following day.

B. Terminal System Performance Objective

The statistics selected to measure the quality of service provided to terminal jobs are system availability and system stability. The performance objective for each terminal system is:

System Stability (MTBF) = 48 hours

System Availability = 95%

In addition to the above two performance objectives the objective of the plan is to provide "satisfactory response" 95% of the time for all terminal systems. The definition of "satisfactory response" and an agreed way to measure response must be defined for

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each terminal system. Perhaps the easiest way to measure system response will be to ask the user whether or not he is happy with system response.

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IV. Current System

The current OJCS computer center houses five large scale IBM computers, (195, 2-65's, 1-67, 1-158), 152-2314 disk drives, 44-3330 disk drives, 40 tape drives, 8 printers, 5 card readers/punches, 2-PDP-8 Mini computers, 2-360/20 computers, 2 plotters, 1 page reader, and required support equipment. Supported by the computer center are 136 CRT terminals, 100 hard copy terminals, and 5 remote printers/card readers.

This hardware is used to support a batch system that processes over 1200 jobs a day, requiring the mounting of 900 tapes, and 100 disk packs each day. The batch jobs are submitted from remote card readers, the CP/CMS time sharing system and at the control point in the computer center. The jobs generate output that is printed locally and at remote printers, sent back to users at CP/CMS terminals, plotted on one of the two plotters, or copied to tape for the creation of microfilm.

The terminal systems run on the ASP machines support numerous dedicated user applications that run all day and each perform a special function for a customer. The CP/CMS time sharing system is used by over 400 people a month, with over 200 people using it on any given day, and 70 to 80 active during the peak hours. The GIM-II information retrieval system is in the final stages of development. Currently there are 23 projects planned to be supported by GIM-II.

The computer center is run 24 hours a day, 7 days a week, except during Christmas and New Years, schedules permitting. Terminals supported by the center are located in headquarters and at some nearby

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locations. The computer center has 13,000 usable square feet of area, with all but about 575 square feet in use.

All machines in the computer center are interconnected through channel-to-channel adaptors for ASP machines, and a communication link to the CP/CMS machine. Control of all ASP machines (4 of the 5) is done by operators from a single set of consoles that are located near the pool of tape drives which are shared by all systems. Mount requests from all ASP machines for tapes and disks are routed to special consoles located in the center of the tape pool. All printers that are used for user output are located in the control point area that is at one end of the computer center in a room next to the machines and tape library. For a logical configuration of the computer center refer to Figure 1 and 2.

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OJCS Computer Center
Logical Configuration

Current System

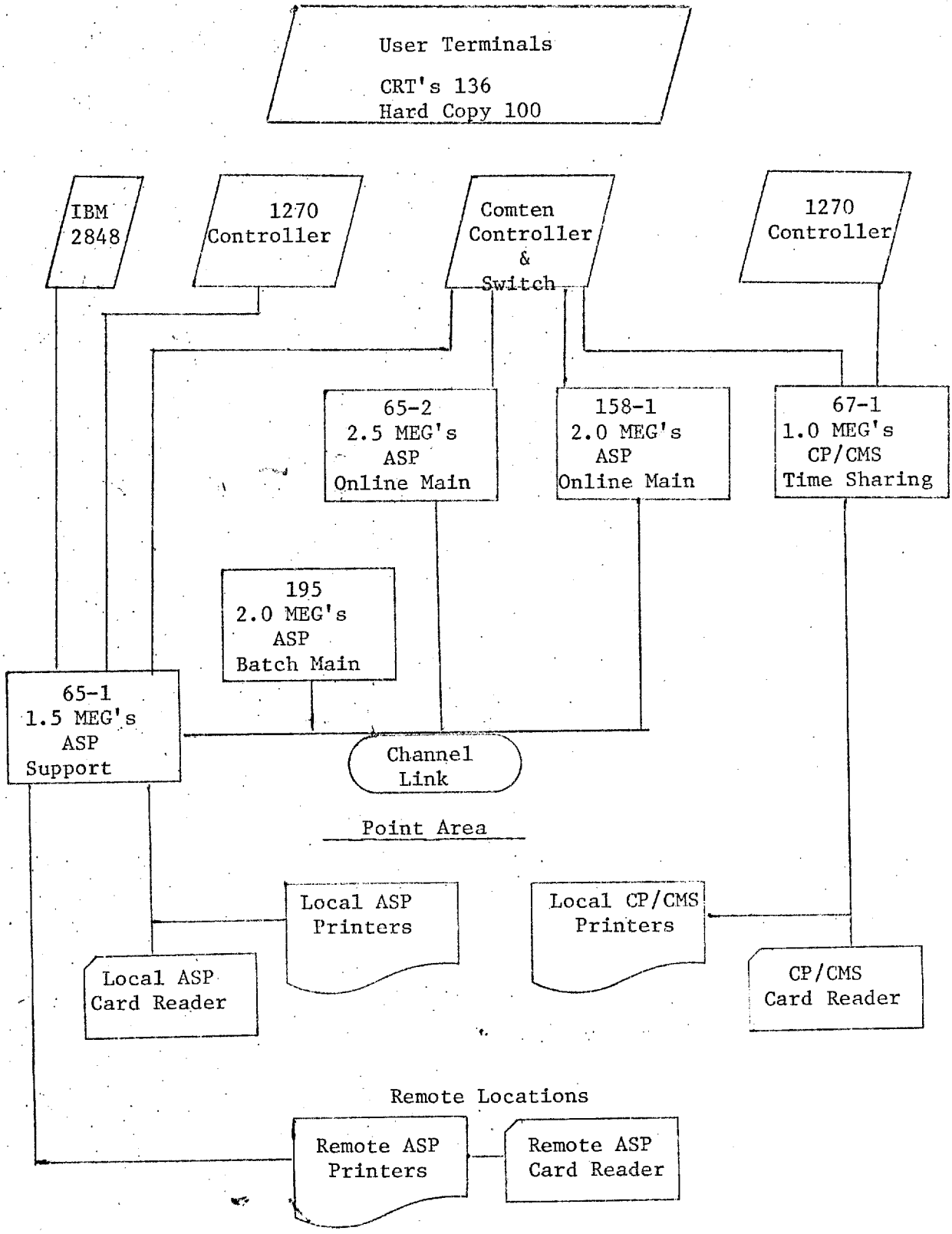

Figure 1. Logical configuration of current system.

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Logical Configuration of Tapes and Disks

Current System

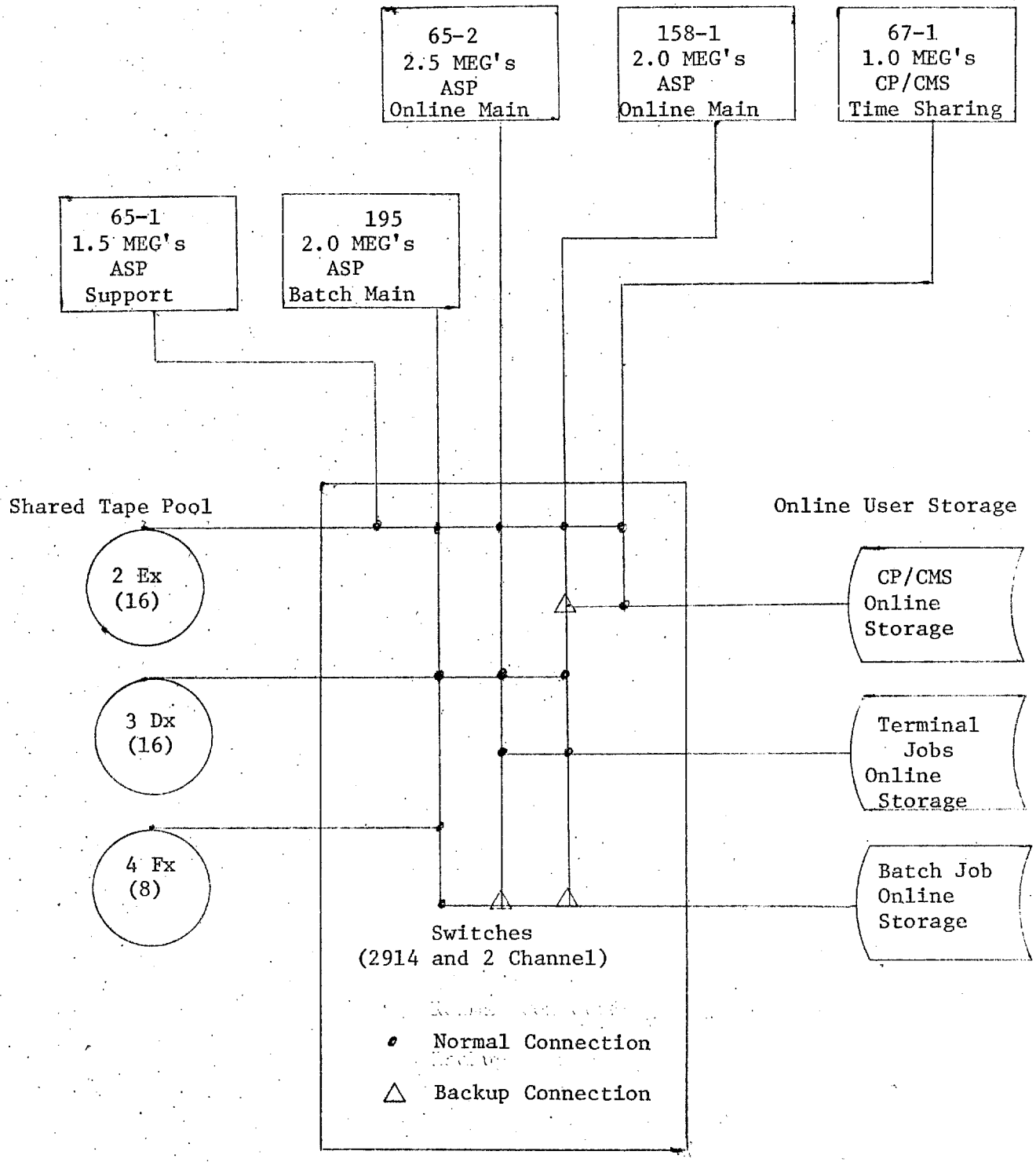

Figure 2. Logical configuration of tapes and disks for current system.

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V. Planned Changes

Major Changes

During the first four phases of the plan (April 1974 to December 1975), three major changes will be made to the center:

1. The Mass Storage System, ORACLE, being developed by the Agency to replace batch job tape and disk setup, and CP/CMS online storage, will be installed in a vault on the first floor.

2. The 360/195 which processes most batch jobs will be replaced with two 370/168's which will process all of the batch jobs and selected terminal applications.

3. A 370/158 running VM will be installed to provide additional support for CP/CMS users now supported by the 67-1 which is saturated during the prime shift. Based on funding this is scheduled for the beginning of FY76.

During the final three phases (1976 to 1978), the following major changes are planned:

1. Replace the 67-1 and 158-2 with a 370/168 running VM.

2. Full production use of the ORACLE system to replace tape and disk drives.

3. Production operation of the SAFE system to support intelligence analysts on a dedicated 168.

4. Installation of the new virtual operating system, on the 168's to replace OS/MVT-ASP. This will provide better use of the new hardware, improved security, and some new functions.

5. The replacement of the owned 360/65's which support terminal applications with a 168 which can run the new virtual operating system.

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Increased Space

The computer center will be expanded to an area on the first floor to house the ORACLE hardware and other unattended hardware which will be moved out of the basement computer center to make room for new machines that must be located near existing equipment. The use of the first floor space should reduce the overcrowded condition of the center so that changes may be made with adequate working space and without excessive shifting of installed equipment as is now required each time new hardware is installed. This additional room should help improve the stability of the systems housed in the OJCS computer center by reducing the number of hardware relocation changes required as systems are expanded to support increased work loads. The additional space has enabled the plan to prolong the useful life of the owned machines which occupy more space than the newer machines of equal capacity.

CP/CMS Support

The unexpected replacement of the 67-2 with a 158, caused by the failure of 3330's to operate reliably on the 67-2, eliminated the hardware that had been planned to provide increased CP/CMS support. Because of budget restrictions and management priorities, the plan provides for only a minor increase in CP/CMS capacity between now and July 1975, although work load projections indicate that a major increase is required. Should management priorities change, appropriate changes can be made to the plan to support the projected work load.

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Additional details concerning the plan are contained in the appendix and the budget section. Schedules for major machine changes and major events are shown in appendix one and two. A list of tasks and changes required for the first three phases is given in appendixes three, four and five. The current allocation of space to equipment in the computer center and an estimate of future space requirements are shown in appendix six and seven. The assignment of applications to machines for each phase is shown in appendix eight. The details used for costing are in appendix nine and ten.

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A. Phase I (April 1974 to June 1974)

The major event during the first phase is the addition of more core to the 195 and the 67-1, and the installation of TMS. The changes planned for Phase I are designed to:

1. Improve the turnaround of batch jobs.

2. Improve the response of the production GIM-II users.

3. Improve the response of the CP/CMS system.

The turnaround time of batch jobs will be improved by making available a larger region on the 195 for processing batch jobs. This will allow more jobs to run concurrently and reduce the chance of a single large core job tying up the entire system. This change will especially help the turnaround of short nosetup jobs which, under normal conditions should wait only a few minutes before beginning execution.

The response of the GIM-II production users will be aided since all development data bases will be moved to the 195 and only fully tested production data bases will be run on the 65-2. Thus, once the 65-2 system is tuned, the users should receive relatively consistent response from the system as long as the production work load is kept within the capacity of the resources allocated to the GIM-II job.

The response of the CP/CMS system will be improved by adding 1 MEG of CDC core to the 67-1 to make it a 2 MEG machine. It is expected that by adding core, the capacity of the 67-1 which is now 50 to 60 users will increase to 70 to 80 active users based on the current profile of system usage. However, the addition of the CDC core may have an adverse impact on system stability until the hardware settles down.

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Toward the end of June a new tape management system, TMS, is planned for production use on the batch system. This will automate many of the functions now required to maintain the tape library. The system will require users to make some changes to their job control statements (JCL) so that information now provided with other control cards, is included in the JCL.

This configuration provides for adequate resources for the batch jobs and OS terminal jobs under normal conditions. Because of constraints on the placement of applications, the batch system and the majority of terminal systems in the center have no backup in the event of a machine failure during the prime shift. For an extended machine failure, (more than four hours) management may elect to take down one set of users to support the users on the machine that is down. Normally users on a machine that fails, will have to wait until the machine is repaired before service is restored. This applies equally to the batch system and the terminal systems.

For a detail list of tasks and changes required for this phase, refer to appendix three.

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B. Phase II (July 1974 to December 1974)

This phase is primarily concerned with getting ready for the installation of two 370/168's and the ORACLE hardware. No major changes to the configuration of hardware or applications are planned during this phase. The major events planned are:

1. Completion of the conversion from Memorex terminal controllers to Comten terminal controllers.

2. Movement of equipment into the newly acquired space on the first floor.

3. Changes to the configuration of peripherals required to support two 168's rather than one 195.

4. Installation of the initial ORACLE hardware in a vault on the first floor.

The Comten terminal controllers combine the terminal control function and the switching function into a single piece of hardware. Once all terminals controllers have been replaced with Comten controllers, the basic configuration of terminal controllers required for the next few years will be completed. As new terminals are installed new line adaptors will be required, but no new controllers.

The newly acquired space on the first floor will be used to house disks and drums that can run unattended. Moving these out of the center will provide space required for the installation of the two 370/168's without having to rearrange the whole center.

During this phase all changes to the configuration of switches and controllers for tapes, disks, and terminals which are required

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to support the two 168's will be completed. The conversion to Comten controllers will include channel interface positions for the two 168's.

During December the initial ORACLE hardware is scheduled to be installed in a vault on the first floor. During this phase the necessary site preparation work will be completed so that the vault will be ready when the hardware is shipped.

For a detail list of changes planned for this phase, refer to Appendix four.

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C. Phase III (January 1975 to June 1975)

The major events during this phase are the replacement of the 195 with two 370/168's and the acceptance of the ORACLE system. During this phase the ORACLE hardware and software will undergo final development, testing, and formal acceptance. Once the first 168 is operational, the 65-1 will be dedicated to supporting ORACLE testing. This will allow the ORACLE development group to place a high load on ORACLE, and yet not impact normal production in the center.

During this phase the only changes in the configuration will be made to the 65-1 and the 195. No changes will be made to the 67-1 and the 65-2 or the 158-1. Refer to Figures 3 and 4 for the logical configuration of the center at the end of Phase III.

The replacement of the 195 with two 168's is designed to provide a more stable batch system, and to provide resources that may be used to support terminal systems that have resource requirements that cannot be met with 360/65's. From a cost benefit standpoint the 168's are more cost effective than the 195 in supporting the type of workload projected for the OJCS computer center. A major difference between the 195 and the two 168's is the price of core and the maximum core configuration of each system. A MEG of core on the 195 costs $20,000 a month compared to $6,000 a month for the 168's. The 195 is limited to a maximum of 4 MEG's while each of the 168's may be expanded to 8 MEG's for a total of 16 MEG's if required. A 3 MEG 195 rents for nearly the same as two 4 MEG 168's.

With the 168's it will be possible to provide consistently good turnaround for batch jobs, especially jobs that are nosetup and have low CPU requirements. The 168's will also allow the core restrictions

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to be eased where this will simplify the development of a batch program.

At the completion of this phase backup for the batch system and the OS terminal applications will be available without impacting other systems. This should improve the availability of the OS supported terminal systems and the batch system as perceived by the user at his terminal.

Growth Capability

The configuration of the center at the end of Phase III will provide excess capacity for batch jobs and OS terminal applications for the next two to three years, based on current projections. Normally the only hardware changes that will be required to support increased work loads, will be additional core, more online storage and terminal adaptors in the Comten.

Installation Plan

To minimize the impact of installing the 168's on the users of the computer center, a four month overlap is planned for the 168-1 and the 195. This will provide adequate time for the first 168 to settle down and for users to resolve any problems that may be caused by differences between the 195 and the 168. The second 168 is scheduled to begin acceptance testing May 1, when the 195 is assumed to go off rent since it will only be used in the case of a major failure of the second 168. The exact release date of the 195 will be determined according to the reliability of the 168-1 and 168-2. The installation plan calls for running the 168-1 and the 195 or the 168-1 and the 168-2 but does not provide for operation of the

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168-1, 168-2 and the 195 due to the peripherals required to support each machine.

Once the 168-1 has stabilized, ASP and the terminal applications supported on the 65-1 will be moved to the 168-1 and the 65-1 will be dedicated to ORACLE testing. After ORACLE testing is completed the 65-1 will share the terminal load of the 65-2.

For a detail list of tasks and changes required for Phase III refer to appendix five.

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OJCS Computer Center

Logical Configuration

End of Phase III

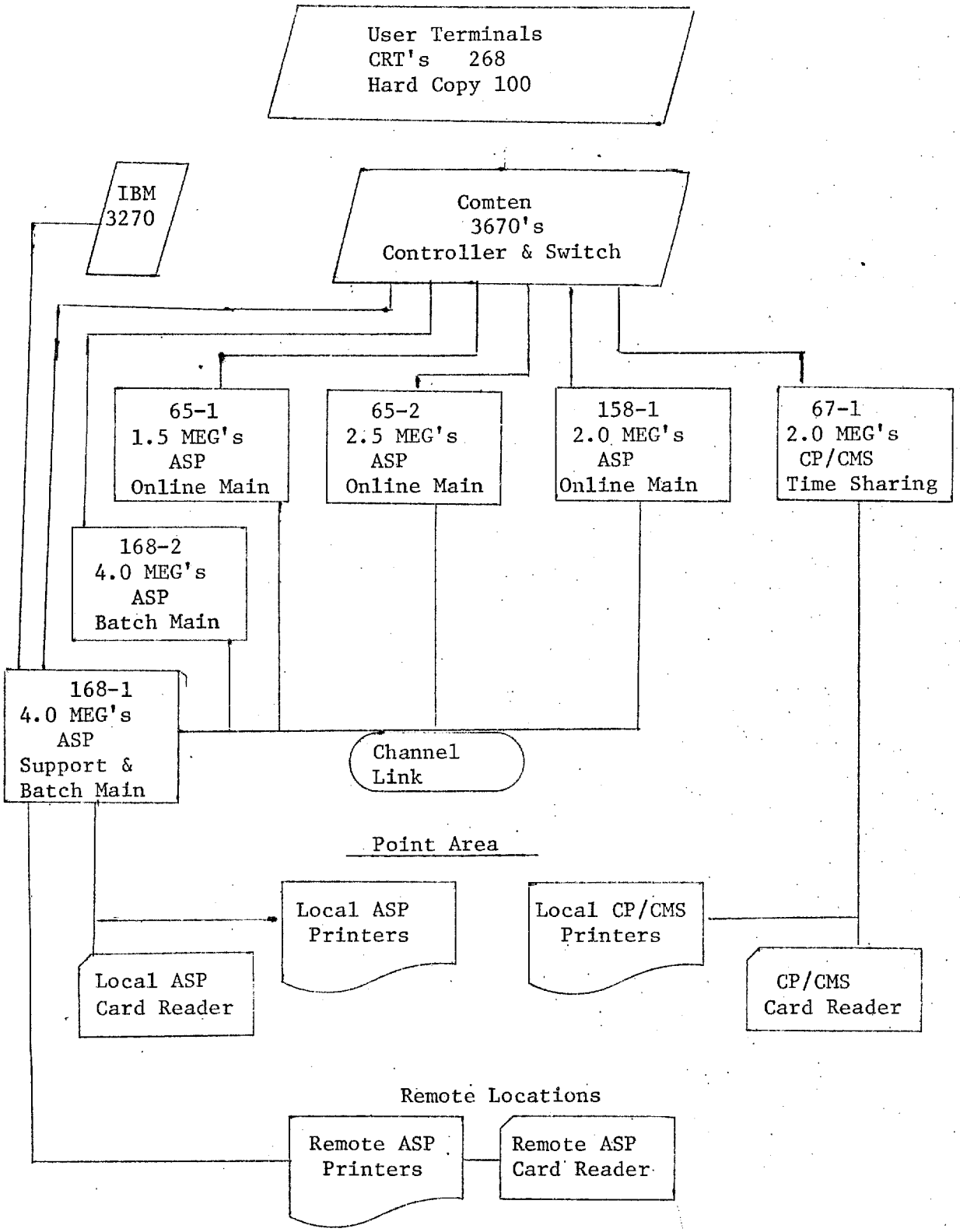

Figure 3. Logical configuration of computer center at the end of Phase III.

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Logical Configuration of Tapes and Disks

End of Phase III

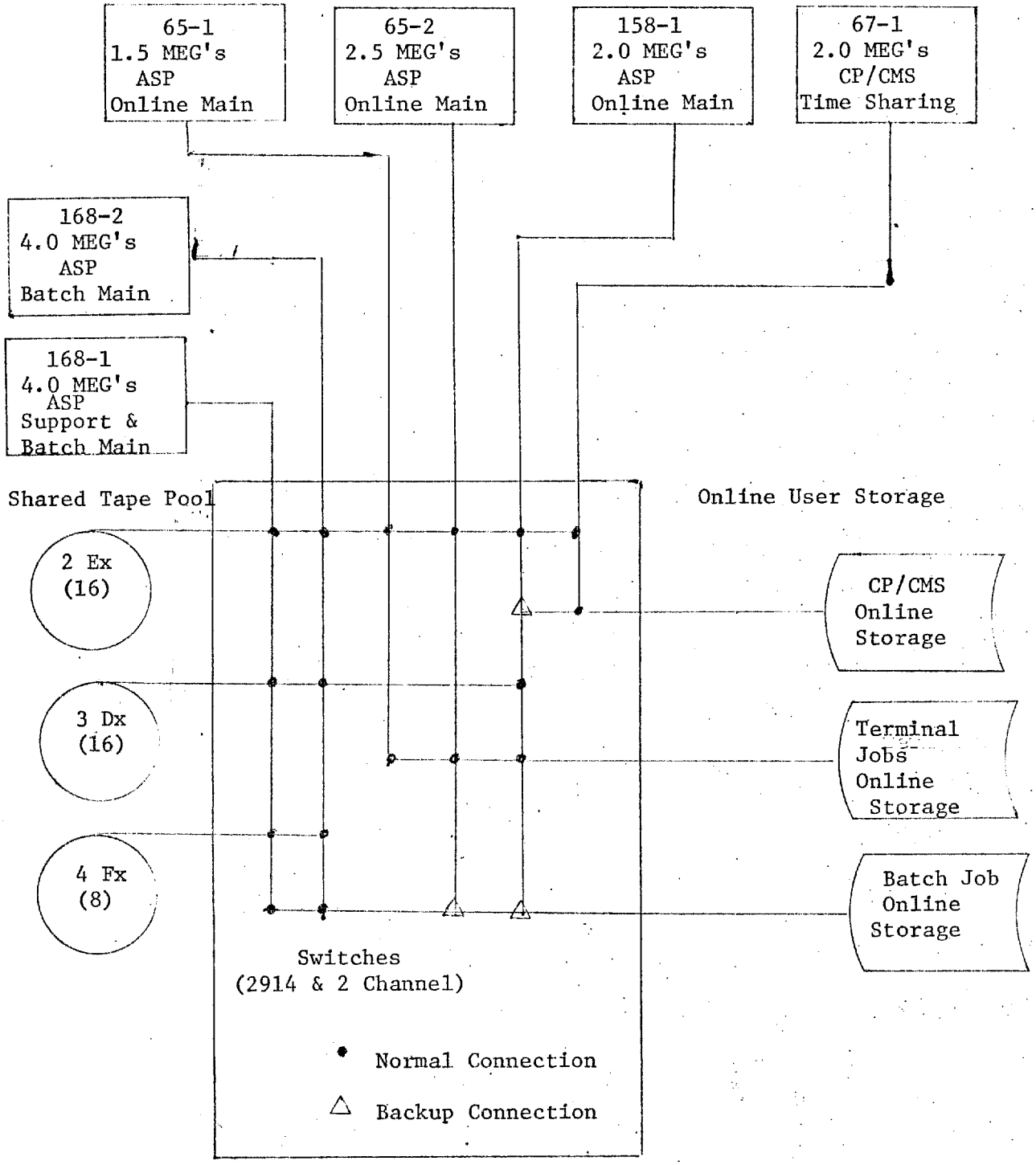

Figure 4. Logical configuration of tapes and disks at the end of Phase III.

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D. Phase IV (July 1975 to December 1975)

The major events during this phase are the installation of a 370/158 running VM and the installation of ASP version 3.1. Other changes planned during this phase are designed to make the best use of the newly installed 168's and to prepare for conversion of production work to ORACLE in the next phase. During this phase software development for the SAFE system is planned to be supported under VM on the 158 using either 370 CMS or VS in a virtual machine. The following events are planned for this phase:

1. Install 158-2 for VM.
2. Install ASP version 3.1.
3. Reconfigure Terminal Applications.
4. Begin SAFE software development.
5. Begin ORACLE production testing.

The installation of the 158-2 for VM will provide increased support for the CP/CMS users and will provide prime time backup for these users. It is planned to continue to operate CP/CMS on the 67-1 under CP67 for an additional year until the 168 for VM is installed. The projected CP/CMS work load for July 1975 is 150 active users during the peak periods which can be supported by the 67-1 and the 158, each of which is estimated to have a capacity of 80 users.

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Based on work load estimates and ease of operation a 168 would be more appropriate for support of CP/CMS users at this point in time. However, it was felt that budget considerations and installation requirements of a 168-3 so soon after 168-2, would make a 168 impractical. Since the 158-1 running VM is used in critical situations to backup selected 67-1 users, support of CP67 and VM is felt to be practical.

The installation of ASP version 3.1 is required to support ORACLE when it goes production in Phase V. In addition, version 3.1 provides new facilities for scheduling interrelated jobs, eliminates the need for setup statements, and has added software reliability. The batch user will be required to make some changes in JCL due to ASP 3.1, but should receive some benefits from the added features.

The reconfiguration of terminal applications will be done to take advantage of the 168's and the 65-1 that is now used as the ASP support processor. The exact configuration of the applications will be dependent on the work loads of each terminal application at the time of reconfiguration. In theory much of the terminal work load planned for the 65-1 and 65-2 could be supported by the 168's by just adding more core. However, it is felt that by dedicating the 65-1 and 65-2 which are owned, to terminal applications, the systems supported by the 65's and the 168's will be more stable.

The SAFE project is scheduled to be doing major development of new software during this phase. Support for this development will be provided using VM on the 370/158. If one of the VS operating systems is chosen to support SAFE then a virtual machine will be used for software development. If CP/CMS 370 is chosen then the

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the SAFE project, adjustments may be required in the hardware required for VM support.

The ORACLE system, which is housed on the first floor in a vault directly over the center of the computer center, is scheduled to complete acceptance testing during April 1975. Also during April 1975 additional hardware for ORACLE will be delivered to increase the capacity to that required for production operation. During this phase the additional hardware will be installed and tested by the ORACLE development group. Following the production use of ASP 3.1, selected users will begin using ORACLE on the production system. This production testing will continue until ORACLE is judged ready for full production use which is planned for January 1976. It is expected that the SAFE project will be a heavy user of the ORACLE system.

E. Phase V (January 1976 to June 1976)

The major event during this phase is the production use of ORACLE and initial production of the SAFE system. The details for ORACLE production are being developed by the ORACLE Planning Group which will publish a separate plan for the installation of ORACLE. The impact of ORACLE on user jobs will be that jobs that now require setup will become nosetup jobs that will run without operator intervention. This should improve the turnaround time of these jobs and reduce the failure rate caused by tape problems.

The impact of initial SAFE production cannot be determined today since the system is still in the planning stages. However, given the range of services being considered for SAFE, initial production support could easily require more effort than is required to put a system such

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as GIM-II or VM into production. The 158 currently used to support CRS work is planned for initial SAFE production support.

F. Phase VI (July 1976 to June 1977)

Plans during the last two phases are included to show the direction of the center. The problems in predicting work load as well as the changes in technology make more detailed plans difficult. During this phase the following events are planned:

1. Install a 168 with VM to replace the 67-1 and 158-2.
2. Full production operation of the SAFE system.
3. Development and installation of VS2R2/JES3 to replace OS/MVT-ASP.

G. Phase VII (July 1977 to June 1978)

During this final phase the following events are planned:

1. Full VS production for batch and terminal applications.
2. Installation of a 168-5 for the increasing SAFE work load.
3. Installation of a 168-4 for the VS2R2/JES3 system to support the workload previously supported on the 65-1 and 65-2.
4. Release of the last owned 360 machines. (65-1 & 65-2)
5. Beginning of development work on the next generation of computers.

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VI. Budget

Budget estimates have been developed to support the plan through fiscal 1978. The budget required to support the configuration of the computer center if no changes were made is 5.833 million a year. The plan calls for changes which increase this to 6.787 million for fiscal 1975, 8.102 million for fiscal 1976, 9.060 million for fiscal 1977 and 10.865 million for fiscal 1978. These costs include hardware to support the estimated SAFE work load. Refer to Table 5 for the monthly cost at the end of each phase by type of service supported. The fiscal year costs of the plan by major system and type of peripheral are summarized in Table 6. The monthly costs by system and type of peripheral at the end of each phase is shown in Table 7.

Purchase options for new hardware have not been fully evaluated. However based on a preliminary study, purchasing CRT terminals and the first two 168's looks like it would result in a financial saving over the life of the plan.

The detail changes and the related costs for each phase are listed in paragraphs VI-A to VI-F. In most cases each change in the budget section relates to a change discussed in section V. However in the case of terminals, these changes were derived from the projected terminal requirements in section II, and they are not explicitly mentioned in section V.

The details used to calculate the base costs are shown in appendix nine and ten. The current allocation of space in the computer center and estimated future space requirements are shown in appendix seven and eight.

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	Monthly Costs at the End of Phase						
Phase - End Date -	Current 4/74	I 6/74	II 12/74	III 6/75	IV & V 6/76	VI 6/77	VII 6/78
Batch	243,517	265,917	270,083	285,459	224,488	214,252	214,252
Terminal Systems	30,323	30,323	33,358	43,012	107,503	107,503	191,751
CP/CMS	28,455	35,074	35,074	35,074	124,453	108,963	108,963
CRS/SAFE	64,461	64,461	59,343	59,343	59,343	90.033	205,975
Shared Hardware	119,149	119,149	121,881	135,255	178,985	211,839	256,589
Total	485,905	514,924	519,739	558,143	694,772	732,590	977,530

Table 5. Summary of monthly costs by type of service.

Note: Shared hardware includes tape drives, ORACLE disk drives, printers/readers, terminals and controllers and miscellaneous.

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	Current No Change	Plan Costs by Fiscal Year ($ Thousands) FY 75	FY 76	FY 77	FY 78
CPU's & System Peripherals					
195 ASP	2534	2335	-	-	-
168-1 ASP		665	1595	1595	1595
168-2 ASP		244	1463	1463	1463
168-4 ASP					1391
65-1 ASP	116	116	116	116	29
65-2 ASP	265	265	265	265	66
158-1 CRS/SAFE	589	589	589	853	853
168-5 SAFE					696
67-1 CP/CMS	153	232	232	58	-
158-2 VM			950	237	-
168-3 VM				1381	1381
Total CPU's	3657	4446	5210	5968	7474
Tape Drives	358	358	358	283	207
User Disk Drives	745	807	986	800	575
ORACLE Disk Drives	68	98	249	269	269
Printers/Readers	189	189	189	189	189
Terminals & Controllers	570	643	864	1305	1905
Miscellaneous	246	246	246	246	246
Total Peripherals	2176	2341	2892	3092	3391
Grand Total	5833	6787	8102	9060	10865
Increase	-	(+954)	(+1315)	(+958)	(+1805)

Table 6. Summary of costs by fiscal year.

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	Monthly Costs at end of Phase						
Phase -	Current	I	II	III	IV & V	VI	VII
End Date -	4/74	6/74	12/74	6/75	6/76	6/77	6/78
CPU's & System Peripherals							
195 ASP	211,135	233,535	233,535				
168-1 ASP	-	-	-	132,942	132,942	132,942	132,942
168-2 ASP	-	-	-	121,942	121,942	121,942	121,942
168-4 ASP	-	-	-			-	115,942
65-1 ASP	9,654	9,654	9,654	9,654	9,654	9,654	-
65-2 ASP	22,040	22,040	22,040	22,040	22,040	22,040	-
158-1 CRS/SAFE	49,107	49,107	49,107	49,107	49,107	71,159	71,159
168-5 SAFE	-	-	-	-	-	-	115,942
67-1 CP/CMS	12,711	19,330	19,330	19,330	19,330	-	
158-2 VM	-	-	-	-	79,143	-	
168-3 VM	-	-	-	-	-	115,081	115,081
Total CPU's	304,647	333,666	333,666	355,015	434,158	472,818	673,008
Tape Drives	29,796	29,796	29,796	29,796	29,796	17,276	17,276
User Disk Drives	62,109	62,109	64,192	67,873	81,629	47,933	47,933
ORACLE Disk Drives	5,630	5,630	5,630	10,586	22,420	22,420	22,420
Printers/Readers	15,740	15,740	15,740	15,740	15,740	15,740	15,740
Terminals & Controllers	47,477	47,477	50,209	58,627	90,523	135,897	180,647
Miscellaneous	20,506	20,506	20,506	20,506	20,506	20,506	20,506
Total Peripherals	181,258	181,258	186,073	203,128	260,614	259,772	304,522
Grand Total	485,905	514,924	519,739	558,143	694,772	732,590	977,530
Increase	-	(29,019)	(4,815)	(38,404)	(136,629)	(37,818)	(244,940)

Table 7. Monthly costs at the end of each phase

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A. Phase I Changes

The following is a summary of the changes planned during Phase I, (April 1974 to June 1974) and their impact on fiscal 1974 budget.

		Date	Monthly Cost of Change	Total FY 74 Change
1.	Add 1 MEG of core to the 195 to make it a 3 MEG machine.	5/74	25,000	50,000
2.	Release four IBM 3330 spindles on the 195 that are being replaced by CDC disks.	5/74	-2,600	-5,200
3.	Add 1 MEG of CDC core to the 67-1 machine to make it a 2 MEG machine to increase support for CP/CMS users.	5/74	6,619	13,238
	Total		29,019	58,038

No

OK ?

CDC CORE NOT SATISFACTORY / AMPEX LMIC IN PLACE OF IBM

1.75 MEG

No ?

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B. Phase II Changes

The following is a summary of the changes planned during Phase II, (July 1974 to December 1974) and their impact on the fiscal 1975 budget.

		Date	Monthly Cost of Change	Total FY 75 Change	
1.	Increase the share packs on the ASP system by adding 1 controller and eight 3330 spindles.	7/74	5118	61,416	OK
2.	Release 1 calcomp dual density 2314 (8 spindles) that was replaced by the 3330 share packs.	8/74	-3035	-33,385	OK
3.	Move 1 calcomp single density 2314 (8 spindles) that was replaced by the 3330 share packs to the 65-2 to support GIM-II data bases. (3035/mo.)	8/74	0	0	OK
4.	Replace the ASP operator consoles with IBM 3270 terminals. Std software	9/74	4365	43,650	OK
5.	Release 2260's and 2848 control units that were replaced by 3270's.	10/74	-5240	-47,160	OK
6.	Replace 4 Memorex 1270 terminal controllers with 2 additional Comten 3670's that will allow all terminals access to any system.	#2 AND 3 (7/74 to 1/75)	+2237	35,859	
7.	Make the 8 CDC 3330's released by the SAFE experiment, the common 3330's for the center. These drives will be shared by all 370 systems and will maintain system related files. (5118/mo)	9/74	0	0	OP/SED ?
8.	Install 40 additional CRT terminals.	11/74	7,320	58,560	OP/SED
9.	Replace 50 IBM 2741 terminals with purchased TI terminals.	1/75	-5,950	-35,700 SED	OP/SED
	Total		4,815	83,240	

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C. Phase III Changes

The following is a summary of the changes planned during Phase III, (January 1975 to June 1975) and their impact on the fiscal 1975 budget.

	Date begin Rental	Monthly Cost of Change	Total FY 75 Change
1. As the first step in replacing the 195 install 168-1 (4 MEG) and related system peripherals. Costs include overtime estimated at $22,000 a month.	2/75	132,942	664,710
2. As the second step in replacing the 195 install 168-2 (4 MEG's) and related system peripherals. Costs include overtime estimated at 11,000 a month.	5/75	121,942	243,884
3. Since the 195 will not be run concurrently with 168-2, it is assumed to go off rent the same day the 168-2 goes on rent although the actual release date will be somewhat later based on stability of 168-1 and 168-2.	5/75	-233,535	-467,070
4. Install two control units and four 3330 spindles for ORACLE testing.	1/75	4,956	29,736
5. Increase the 3330's for share packs on the ASP system by 1 control unit and 8 packs.	1/75	5,118	30,708
6. Install an additional control unit for the common 3330's for use by the 168-1.	1/75	1,598	9,588
7. Release a calcomp single density 2314 disk unit (8 spindles) that was used for ASP spool packs.	5/75	- 3,035	-6,070
8. Install 46 additional terminals.	5/75	8,418	16,836
Total		38,404	522,322

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D. Phase IV and V Changes

The following is a summary of the changes planned during Phase IV, (July 1975 to December 1975) and Phase V (January 1976 to June 1976) and their impact on the fiscal 1976 budget.

		Date	Monthly Cost of Change	Total FY 76 Change
1.	Install 158-2 (4 MEG's) and system peripherals to increase the support for CP/CMS users. Costs include estimated overtime of $13,000/month.	7/75	79,143	949,716
2.	Install 2 control units and sixteen 3330 spindles for VM p-spaces.	7/75	10,236	122,832
3.	Install two control units and sixteen 3330 spindles for support of GIM-II data bases on the 168's.	7/75	10,236	122,832
4.	Release 2 calcomp single density 2314 disk units that were replaced by GIM-II 3330's.	8/75	-6,716	-73,876
5.	Install four 3330 spindles for ORACLE testing.	7/75	1,760	21,120
6.	Install 3 control units and twelve 3330 spindles for production use by ORACLE on the ASP system and development on the VM system.	9/75	10,074	100,740
7.	Install 100 additional CRT terminals.	1/76	18,300	109,800
8.	Install 50 additional CRT terminals.	6/76	9,150	9,150
9.	Upgrade Comten for 128 more lines.	7/75	2,534	30,408
10.	Upgrade Comten for 64 more lines.	1/76	1,912	11,484
	Total		136,629	1,404,206

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E. Phase VI Changes

The following is a summary of the changes planned during Phase VI, (July 1976 to June 1977) and their impact on the fiscal 1977 budget.

		Date	Monthly Cost of Change	Total FY 77 Change
1.	Install 168-3 (4 MEGS) and system peripherals running VM, to replace the 67-1 and 158-2 which support CP/CMS users.	7/76	115,081	1,380,972
2.	Release the 67-1 that was supporting CP/CMS users.	10/76	-19,330	- 173,970
3.	Release the 158-2 that was replaced by the 168-3.	10/76	-79,143	- 712,287
4.	Upgrade the 158-1 to support the SAFE system, (+2 MEG & DRUMS)	7/76	+22,052	+ 264,462
5.	Install 1 control unit and sixteen 3330's spindles for the storage requirements of the SAFE project.	7/76	8,638	103,656
6.	Release 2 control units and sixteen 3330 spindles used for ASP share packs due to ORACLE production.	10/76	-10,236	-92,124
7.	Release 2 control units and sixteen 3330 spindles used for VM p-spaces due to ORACLE production.	1/77	-10,236	-61,416
8.	Release 6 calcomp dual density 2314 disk units (48 spindles) and 2 calcomp single density 2314 disk units (16 spindles) due to ORACLE production.	1/77	-21,862	- 131,172

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E. Phase VI Changes - cont'd

		Date	Monthly Cost of Change	Total FY 77 Change
9.	Install 100 additional terminals.	10/76	18,300	164,700
10.	Release 4 control units and 16 tape drives due to ORACLE production.	1/77	-12,520	-75,120
11.	Install fourth Comten for SAFE with 128 lines.	1/77	5,384	32,304
12.	Install 100 additional terminals.	6/77	18,300	18,300
13.	Upgrade Comten with 128 more lines.	6/77	3,390	3,390
	Total		37,818	721,695

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F. Phase VII Changes

The following is a summary of the changes planned during Phase VII, (July 1977 to June 1978) and their impact on the fiscal 1978 budget.

		Date	Monthly Cost of Change	Total FY 78 Change
1.	Install 168-4 (4 MEGS) and system peripherals to increase the capacity of the ASP system to support batch work and online applications.	7/77	115,942	1,391,304
2.	Release the 65-1 and 65-2 due to the work being moved to the 168-4 running the new virtual operating system that cannot be run on the 360's.	10/77	-31,965	-287,685
3.	Install 168-5 (4 MEGS) and system peripherals to provide added support for the SAFE system. The 158 supporting SAFE is assumed to continue to be used for SAFE related work.	1/78	115,942	695,652
4.	Install 250 additional terminals. (150 - SAFE and 100 - OJCS)	1/78	44,750	274,500
	Total		244,669	2,073,771

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VII. Alternatives Considered

The following is a discussion of some of the major alternatives considered during development of the plan. The list is not exhaustive, but does attempt to cover the more popular issues discussed.

A. Keep the 195 through ORACLE production.

An alternative was considered which would have kept the 195 through the installation of the ORACLE system. While this option would have provided the required raw CPU power, it was not felt that it provided the most service for the cost. The benefits gained from the increased core capacity of the 168's, and the increased availability due to having two major systems instead of one, were the major reasons why it was decided to replace the 195.

B. Early Replacement of Purchased 360/65's.

Prior to the allocation of additional space to the OJCS computer center, plans were developed to replace the purchased 360/65's and 360/67's with leased 370/158's or 370/168's as a way to support the projected work load within the confines of the current computer center. Another motivation for the replacement of the purchased machines was to keep down the number of systems that had to be operated.

It was decided to keep the purchased machines and use them to support terminal applications that do not require the power of 370/168's. While this decision will increase the number of machines in the center to more than would normally be planned, the expected benefit is felt to outweigh the added problems.

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By placing some terminal applications on the 65's, the applications supported on the 168's will be indirectly aided since the number of terminal jobs on the 168 will be limited to applications that require the added power of a 168. In theory all of the applications planned for the 65's could be supported on the 168's by simply adding more core. In practice as the number of jobs on a system increases, so does the complexity of the system, resulting in a loss in stability.

C. Early conversion to VS (1975 to 1976)

An option was considered which called for installing the new Virtual Operating system early in 1975 so as to take full advantage of the new 168's. This was rejected since it was felt that too many other tasks of a higher priority were scheduled during this time period. In addition it was felt that the new system should be given a year or so to settle down before it is installed in the center. The feeling is to let other users find the bugs since the current systems are more than adequate to support the projected work load.

D. ASP Version 3.1 in November 1974.

The original date for the installation of ASP version 3.1 was November 1974 which was selected so that ASP would be stable when ORACLE went production and would be available for ORACLE Acceptance testing.

The installation of ASP 3.1 in November of 1974 would have required the rescheduling of the 168's for the middle of 1975

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since it was felt that about 6 months should be provided for ASP to settle down before making a major hardware change. This schedule would have placed the installation of the 168's during the scheduled production cut over for ORACLE, or at best placed ORACLE production just after the 168 installation. A six month slippage of the 168's would also place in doubt the ability of the center to support the GIM-II work load, if in fact, the real work load is on the high side of the estimates.

The plan developed calls for the 168-1 to free up the 65-1 during February 1975, so that it can be dedicated to ORACLE development and final Acceptance testing running ASP version 3.1 in a test environment. This will provide excellent support for ORACLE development and allow the ASP version 3.1 development team added test time.

With the plan the installation date for ASP 3.1 will be between May and July 1975 depending on when the 168 installation is completed. Since ASP 3.1 will have had almost 4 months of operation during the ORACLE Testing period, the production installation should be smoother.

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VIII. Major Issues and Uncertainties

In developing the plan some issues were identified as having the potential to require a significant alteration to the plan in the future. These are discussed in the following sections.

A. CP/CMS Support

The plan projects a CP/CMS work load of 108 active users by July 1974, 150 by July 1975 and 200 by July 1976 when a 168 running VM is planned. With the replacement of the 67-2 with a 158 running OS/MVT the plan only provides capacity for 70 to 80 users between now and July 1975. This assumes the addition of 1 MEG of CDC core to the 67-1 which is estimated to increase the capacity of CP/CMS from 50-60 users to 70-80 users. However based on past experience the addition of CDC core to the 67-1 could decrease the stability of the system such that the loss in stability would cancel out the benefit of the increased capacity.

The level of support provided by the plan for CP/CMS users between now and July 1975 is not up to the performance objectives stated in section III. Unless the demand for CP/CMS service is reduced by denying service to some current users and all future users, continued customer dissatisfaction with the quality of CP/CMS service can be expected between now and July 1975. Due to the nature of the CP system, as more users attempt to use the system than it is capable of supporting, the level of service for all users on the system degrades to a point where no one on the system gets much work done due to poor response.

Therefore until additional capacity is provided, restrictions should be placed on usage of the CP/CMS system to prevent system

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saturation which results in no one getting service. Once guidance is provided as to who is to be denied service, appropriate plans can be developed to restrict CP/CMS usage so as to prevent continued system saturation.

Should management priorities change, so that additional CP/CMS capacity is to be provided, appropriate changes can be made to the plan to support the projected work load.

B. ORACLE Production Date

Since ORACLE is a developmental project, it is possible that there could be some slippage in the production date. A six month freeze is planned at the beginning of ORACLE production so as to minimize the impact to the user. Should the production date slip, then some of the events scheduled after ORACLE may need to be moved up since they could not withstand the same type of slippage. This applies particularly to the 168 for VM since the work load projected for CP/CMS will be at or near saturation level when the 168 is installed. A slippage of this date could cause real problems for the CP/CMS users if the workload projections are accurate.

C. Support of a Large Number of Terminals

The plan projects nearly 1000 terminals supported by the OJCS center in 1978. The design of the current terminal controllers is not sufficient to handle efficiently such a large number of terminals. During the planning period, a detailed plan needs to be developed to support the number of terminals projected.

D. Support of Remote Printers and Readers

The plan assumes an increase in the number of remote printers

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and card readers as well as other remote input/output devices. Currently these devices are supported by ASP using standard software supplied by IBM. As the number of these devices increases, along with the classification of the data printed, additional effort may be required to supplement the software supplied by the vendor, for support of remote devices.

E. GIM-II Work Load

The GIM-II system is a general purpose, information retrieval system developed in part by the Agency. Being general purpose, there are a variety of ways it can be used to do a similar function. Since it is new, applications that it can best support are still being identified. By virtue of being both new and general purpose, it is very difficult to predict the work load, or the resources required to support the work load. For this plan, the resources allocated to GIM-II support can be from a dedicated 360/65, to the better part of a 168 or both. Since the work load is not accurately defined, the resources required to support it cannot be accurately defined.

For the next two years it is felt that adequate resources will be available to support the projected GIM-II workload as long as reasonable use is made of the system.

F. New Terminal Services

This plan has not included the introduction of any new terminal services. The center currently supports the APL language under the CP/CMS system using an agency developed monitor. For a small number of users this is a reasonable means to support APL. However if the usage of APL increases significantly, then a more efficient means

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of support would be required.

There has been considerable discussion within the office over the merits of adding the Basic language to the services supported by the center. Versions of Basic do exist that run under CP/CMS as well as on mini computers, and under OS/MVT. Both Basic and APL are languages designed to be used with terminals by users that are not programmers. It is quite likely that there will be increased requirements for Basic or APL service in the following years. As these requirements are defined, adjustments will have to be made to the plan to provide the required support.

G. DDO Computer Center

While this plan was being developed, the relationship of the DDO computer center to the OJCS center was not defined. Therefore the plan makes no change to the DDO center during the planning period. Once a management position on the DDO center is defined, appropriate changes will be made to the plan.

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Appendix

1. Schedule of major machine changes
2. Schedule of major events
3. Tasks and changes Phase I
4. Tasks and changes Phase II
5. Tasks and changes Phase III
6. Current allocation of space in computer center
7. Space requirements at the end of each phase
8. Assignment of applications to machines at the end of each phase
9. Detail of configurations and peripherals used for system costing.
10. Detail of configurations used to calculate Table 6, costs of services.

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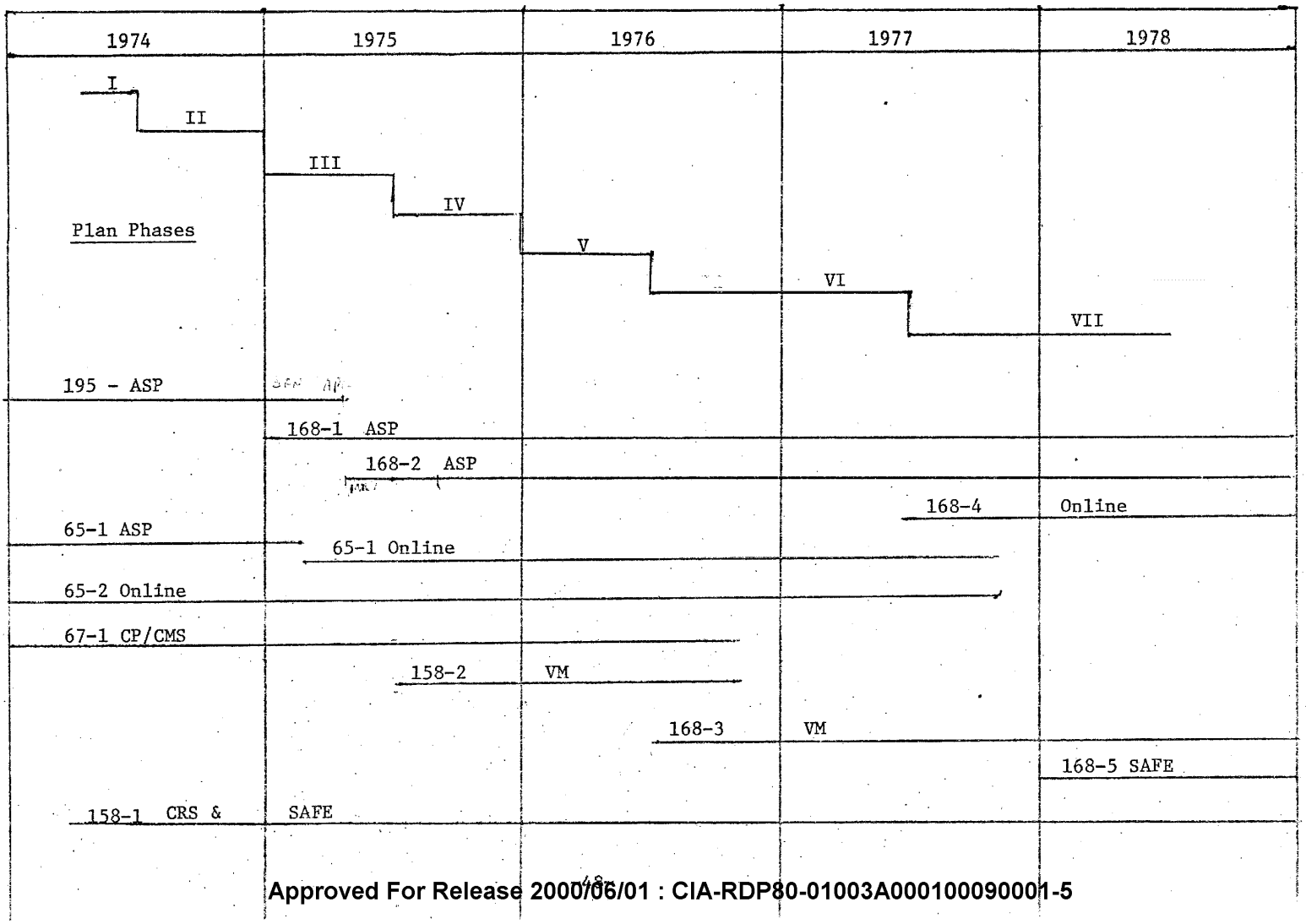
Appendix 1. Schedule of Major Machine Changes



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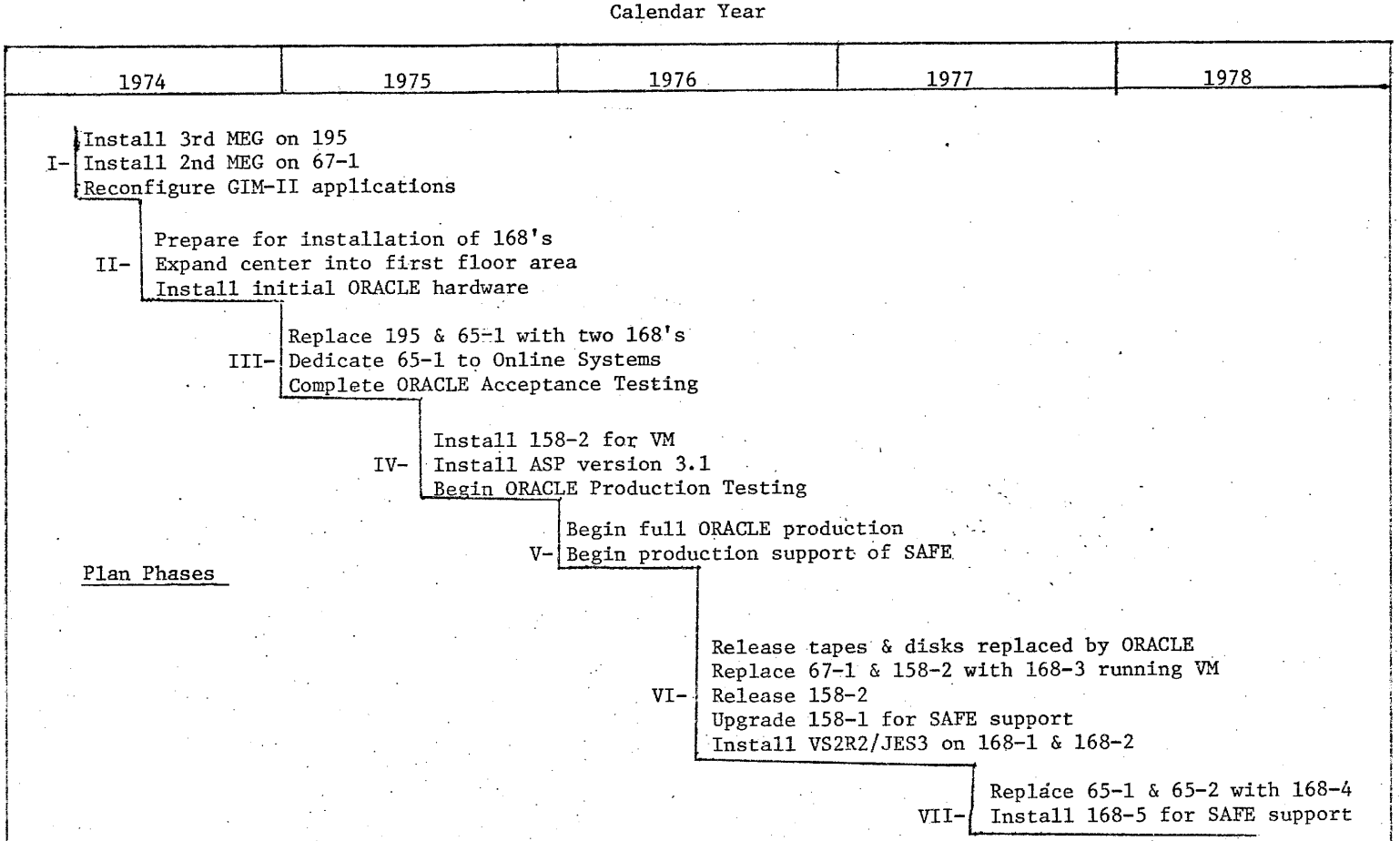
Appendix 2. Schedule of Major Events


Calendar Year
1974
1975
1976
1977
1978
I- Install 3rd MEG on 195
Install 2nd MEG on 67-1
Reconfigure GIM-II applications
II- Prepare for installation of 168's
Expand center into first floor area
Install initial ORACLE hardware
III- Replace 195 & 65-1 with two 168's
Dedicate 65-1 to Online Systems
Complete ORACLE Acceptance Testing
IV- Install 158-2 for VM
Install ASP version 3.1
Begin ORACLE Production Testing
V- Begin full ORACLE production
Begin production support of SAFE
Plan Phases
VI- Release tapes & disks replaced by ORACLE
Replace 67-1 & 158-2 with 168-3 running VM
Release 158-2
Upgrade 158-1 for SAFE support
Install VS2R2/JES3 on 168-1 & 168-2
VII- Replace 65-1 & 65-2 with 168-4
Install 168-5 for SAFE support

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Appendix 3. Phase I Tasks and Changes

1. Divide the MAD hourly run into two jobs, and move the terminal portion off of the 195 to a terminal main.

2. Change the normal line used for the RJP link between ASP and Batchmon from the Comten to a Memorex 1270.

3. Move the Comten interface from the 65-1 to the 195.

4. Do a new Comten sysgen for the new application configuration.

5. Install the third MEG of core on the 195.

6. Install the second MEG of core on the 67-1.

7. Reconfigure the GIM-II applications so that all production data bases are on the 65-2 under a single job and all development work is on the 195.

8. Establish online storage on the 195 for the GIM-II development batch and online system.

9. Establish procedures for validating a GIM-II application before it is moved from the development machine to the production machine.

10. Install TMS on the ASP system.

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Appendix 4. Tasks and changes for Phase II

1. Install Comten 3670-2 and 3670-3 to replace all Memorex 1270's.
2. Move drums and disks to the first floor.
3. Make the Gould plotter online to ASP.
4. Prepare the space on the first floor for ORACLE.
5. Move ASP share packs from 2314 to 3330's.
6. Increase the number of 3330's allocated to share packs to reduce disk setup.
7. Install needed switches for disks that will be used by the 168's.
8. Install 6400 BPI feature on 8 tape drives for use by AEGIS master files, large SAFE files, and disk pack backup.
9. Convert SANCA, QT2260 and Shoebox to delta data's or 3270's.
10. Replace the ASP 2260 and 2741 consoles with 3270's.
11. Make available a new version of CMS that is IPL'ed at LOGON by CP.
12. Shorten the CP logon sequence so that userid and prism project may be entered on the same line to speed up the logon process.
13. Make available to general users the option of having a primary p-disk defined in their virtual instead of having to link, similar to the setup used by SED.
14. Establish a Common bank of 3330's to replace the function of the Common 2314 unit once the 168's are installed.
15. Increase the disk units on the 65-2 for GIM-II production.

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Appendix 5. Tasks and changes Phase III

1. Ship 168-1.
2. Build up 168-1 in center.
3. IBM turn over 168-1 to SED.
4. System tests of OS/MVT, LASP, ASP MAIN to 65-1.
5. Job Stream Tests on Block Time.
6. Connect 168-1 channels to switches for production tapes and disks.
7. System tests on Block Time using production tapes and disks of OS/MVT, LASP, and ASP MAIN from 65-1.
8. Block time Job Stream Tests using production I/O.
9. Block Time System tests of Dual MAIN (168-1 and 195) with 65-1 support.
10. Block Time Job Stream tests with Dual MAIN's (168-1 and 195) with 65-1 support.
11. Block time System tests with 168-1 support.
12. Block time System tests with 195 support of 168-1.
13. Block time Job Stream tests with 168-1 support.
14. Block time Job Stream tests with 195 support of 168-1.
15. Production use of 168-1 as ASP main.
16. Pause period for 168-1 main to settle down.
17. Block time tests of terminal jobs on 168-1.
18. Move ASP support to 168-1 for production.
19. Saturation loading of 168-1 with production work, minimum usage of 195.
20. Turn over 65-1 to ORACLE development group.
21. Move terminal jobs to 168-1.
22. Ship 168-2.

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Appendix 5 - cont'd

23. Build up 168-2 in center.

24. IBM turn over 168-2 to SED.

25. System tests of 168-2 with OS/MVT, LASP, and ASP.

26. Block time job stream tests with 168-2 ASP main from 168-1 support.

27. Block time job stream tests with 168-2 ASP main from 195 support.

28. Connect 168-2 channels to switches for production tapes and disks.

29. Block time system tests using production I/O.

30. Block time job stream tests using production I/O.

31. Production use of 168-2 as ASP main to replace 195.

32. Pause period with 195 idle.

33. Release 195.

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Appendix 6. Current allocation of space in OJCS computer center

Usage	Square Feet	
CPU"s, Memory & Channels		
67-1	800	
65-1	600	
65-2	600	
195	1000	
158-1	325	
Total		3325
Tape Pool	1600	
Disks & Drums	2000	
Terminal Controllers	900	
Peripheral Equipment	800	
Total		5300
Work Areas	800	
Point Area	1080	
Tape Library	1140	
Offices	780	
Total		3800
Available (Paper Storage)		575
Grand Total		13,000

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Appendix 7. Space requirements at end of each phase

Square Feet by Type of Use

Phase	CPU's	Disks	Other	Total
Current	3325	2000	7100	12,425
I	3325	2000	7100	12,425
II	3325	2076	7100	12,495
III	3925	2510	7100	13,535
IV	4250	3010	7100	14,360
V	4250	3010	7100	14,360
VI	3925	2310	6800	13,035
VII	4325	2430	6800	13,555

Notes:

1. In addition to the above space about 1000 square feet is required for staging the installation of a 168.

2. The vault for ORACLE is not included in the above space requirements.

3. Refer to Appendix 6 for the allocation of "Other" space which is assumed constant for the plan.

4. Each machine includes the space for the CPU, memory and channels, console, collant distribution unit, and power distribution unit. For the 158 these are all included in one piece of hardware.

5. In addition to the CPU space each new ASP system includes 60 square feet for drums and 220 square feet for system disks in the disk column. Each new VM machine includes space only for drums at 60 square feet in the disk column.

6. All new 3330's are assumed to be CDC with a space requirement of 150 square feet for each unit of 1 controller and 8 spindles.

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Appendix 8. Assignment of applications to machines at the end of each phase

Service or Application	Machine Assignment end of Phase							
	Current	I	II	III	IV	V	VI	VII
Batch	195	195	195	168-1 168-2	168-1 168-2	168-1 168-2	168-1 168-2	168-1 168-2
ASP Support	65-1	65-1	65-1	168-1	168-1	168-1	168-1	168-1
Dedicated User Terminal Systems	65-2	65-2	65-2	65-1 65-2	65-1 65-2	65-1 65-2	65-1 65-2	168-4
GIM-II Production	65-2	65-2	65-2	65-2	168-2	168-2	168-2	168-4
GIM-II Development	195	195	195	168-1	168-1	168-1	168-1	168-1
CRS/SAFE	158-1	158-1	158-1	158-1	158-1	158-1	158-1	158-1 168-5
CP/CMS	67-1	67-1	67-1	67-1	67-1 158-2	67-1 158-2	168-3	168-3
	5	5	5	6	7	7	6	6

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Appendix 9. Detail of configurations and peripherals used for system costing.

		Monthly Costs	
1.	195 - ASP		
	Basic Machine	140,115	
	Channels (8)	14,600	
	Drums (2)	8,652	
	3330 System disks (16)	12,768	
	Overtime	35,000	
	Total		211,135
2.	65-1 ASP		
	1 MEG CDC core	6,619	
	2314 system disks (8)	3,035	
	Total		9,654
3.	65-2 ASP		
	2 MEG CDC core	13,236	
	2314 system disks (8)	3,035	
	Drums	5,769	
	Total		22,040
4.	67-1 CP/CRS		
	1052	63	
	Channels	4,120	
	2314 System Disks (8)	3,035	
	Drums	5,493	
	Total		12,711
5.	158-1 CRS		
	Basic machine	42,072	
	2314 System disks (8)	3,035	
	Overtime	4,000	
	Total		49,107
6.	Tape Drives		
	8 Control units	6,560	
	36 3420-7 Tape drives	20,988	
	4 3420-7 7th tape drives	2,248	
	Total		29,796

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7.	User Disks Drives		
	Batch		
	4 Single Density 2314 @ 3035	12,140	
	1 Dual Density 2314	2,624	
	1 CDC 3330 (4)	3,840	
	1 IBM 2314 (common)	4,124	
	Total		22,778
	Terminal Systems		
	1 Single density 2314	3,035	
	2 Dual density 2314 @ 2624	5,248	
	Total		8,283
	CP/CMS		
	6 Dual density 2314 @ 2624	15,744	
	Total		15,744
	CRS		
	3 CDC 3330's (8) @ 5118	15,354	
	Total		15,354
	Total User Disks		(62,109)
8.	ORACLE Disk Drives		
	2 CDC 3330 (2) GFE to Ampex @ 2815	5,630	
	Total		5,630
9.	Printers/Readers		
	3 3211 Printers @ 2408	7,224	
	5 1403 Printers @ 840	4,200	
	1 Extra Print Chain	97	
	1 2821 Controller	1,059	
	4 2540 Readers/Punches @ 710	2,840	
	1 2501 Card reader	320	
	* Some 2821's are owned		
	Total		15,740
10.	Terminals & Controllers		
	28 2260's @ 50	1,400	
	95 2741's @ 119	11,305	
	2 3272-2 CRT's @ 165	330	
	2 3286-2 Printers @ 190	380	
	10 APL Delta Data CRT's @ 190	2,280	
	51 Delta Data CRT's @ 183	9,333	
	106 Purchased CRT's		
	2 CE's for maintenance	3,334	
	Total		29,762
	4 2848 controllers (2260) @ 950	3,840	
	1 3272 controller	205	
	4 1270's @ (3290, 2660, 2085, 2835)	10,870	
	1 3670-1 Comten (partly owned)	2,800	

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	Total Terminals		(47,477)

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11.	Miscellaneous		
	2250	2,838	
	Paper tape	1,462	
	2914 switches	4,995	
	Key punches	3,385	
	Software	915	
	IBM office equipment	544	
	GE & GTE terminals	679	
	Misc. software	2,000	
	Univac key punch	3,002	
	TI printer	211	
	DCM modem	190	
	CDC page reader	285	
	Total		20,506

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Appendix 10. Detail of configurations used to calculate Table 6.

		Monthly Costs From Appendix 9	
1.	Batch Systems		
	195	211,135	
	65-1	9,654	
	Disks	22,728	
	Total		243,517
2.	Terminal Systems		
	65-2	22,040	
	Disks	8,283	
	Total		30,323
3.	CP/CRS		
	67-1	12,711	
	Disks	19,744	
	Total		28,455
4.	CRS/SAFE		
	158-1	49,107	
	Disks	15,354	
	Total		64,461
5.	Shared hardware		
	Tape Drives	29,796	
	ORACLE disks	5,630	
	Printers/Readers	15,740	
	Terminals	47,477	
	Misc.	20,506	
	Total		119,149

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